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PATENT OFFICE
27 MAR 1998
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1. Your reference

SAB/MS/CLARKE.3/42448/000

2. Patent application number
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9806713.5

27 MAR 1998

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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TANYARD FARM
LOWER WEARE, NR AXBRIDGE
SOMERSET BS26 2JG

Patents ADP number *(if you know it)*

7406721001

If the applicant is a corporate body, give the country/state of its incorporation

NO

4. Title of the invention

A TAPERED STRUCTURE

5. Name of your agent *(if you have one)*

WITHERS & ROGERS

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

4 DYER'S BUILDINGS
HOLBORN
LONDON EC1N 2JT

Patents ADP number *(if you know it)*

1776001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

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a) any applicant named in part 3 is not an inventor, or
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Continuation sheets of this form	
Description	8
Claim(s)	--
Abstract	--
Drawing(s)	11

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Request for preliminary examination and search *(Patents Form 9/77)*	--
Request for substantive examination *(Patents Form 10/77)*	--
Any other documents *(please specify)*	--

11. I/We request the grant of a patent on the basis of this application.

Signature Withers & Rogers Date

WITHERS & ROGERS 26th MARCH 1998

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A TAPERED STRUCTURE

This invention relates to a tapered structure. Such a structure can formed from a sheet of foldable material. The invention also relates to a blank of foldable sheet material for forming the tapered structure.

In the field of acoustics, horns are generally classified according to their geometrical shape. Figure 1 shows, for example, a pyramidal horn with an open rectangular base, and a tubular wall comprising four planar tapezoidal shaped panels. The apex of the pyramid is truncated to form a throat section through which acoustic energy may be transmitted or received.

Figure 2 shows a conical horn in which the tubular wall forms a continuous panel circumscribing an acoustic channel within. The geometrical structures shown in Figures 1 and 2 are characterised by their cross-sectional area increasing linearly with the distance from their throat. These structures, by virtue of their shape, may be formed from a single sheet of foldable material. The blank for the pyramidal horn is shown in Figure 4, with the four panels labelled 41, three fold lines labelled 42, and a tab for holding the structure together labelled 43.

Figure 3 shows a sectoral horn in which one of the set of two opposing panels are planar and parallel, and the other set of opposing panels are flared. This particular structure is characterised by the cross-sectional area increasing non-linearly with the distance from the throat. The cross-sectional area may, for example, be dependent on an exponential or tractrix function of the throat distance. This non-linearity of the cross-sectional area improves the

efficiency of the horn structure in channelling acoustic energy to or from the throat. However, whereas the shape of the structures of Figures 1 and 2 enable them to be formed from a sheet of foldable material, the geometrical structure of Figure 3 must be formed using a different method, such as by welding or gluing together the separate panels.

According to a first aspect of the present invention there is provided a tapered structure formed from a sheet of foldable material, the tapered structure comprising a wall member having a plurality of fold lines defining the edges of a plurality of juxtaposed panels, characterised in that two adjacent fold lines are curved to form a non-planar panel bound by said curved fold lines.

A structure in accordance with the present invention has an advantage that it by using curved fold lines instead of straight fold lines as used in the pyramidal horn, a panel or panels of the structure may be made non-planar and preferably flared. The use of curved interfaces between adjacent panels enhances the strength of the structure and its ability to withstand sheering and crushing forces.

Suitably, the structure has a base end and an apex end, also referred to as the mouth and the throat respectively. It is possible that one or both of these ends is closed.

In a preferred embodiment, at least one pair of the curved fold lines converge towards the apex end, and may contribute to the general convergence of the tapered structure i.e. the decrease of the cross-sectional area towards the throat.

Preferably at least one pair of the curved fold lines converges towards the base end of the tubular wall. In this case, the curved fold lines may converge to a point at or near the base end.

Ideally, the non-planar panel has a concave external appearance, and has mirror symmetry in a plane substantially perpendicular to the panel.

Advantageously, the wall member may include a second non-planar panel, opposite the first non-planar panel, and also having a concave external appearance. The first and second panels may be of different size and one or both may stop short of the base. Advantageously fold lines may be disposal in the non-planar panels, thereby allowing the tapered structure to be folded flat. This is advantageous for transport and storage.

The wall member may include two further opposing non-planar panels, joining the first and second non-planar panels, and having a convex external appearance.

A preferred embodiment of the invention has first and second non-planar panels which are generally elliptically shaped. Alternatively, the first and second non-planar panels may be regarded as being generally petal shaped. In a further embodiment, the first and second non-planar panels may be regarded as being generally trapezoidal shaped with the non-parallel sides being curved.

In one embodiment of the invention, the base and/or apex end of the wall member may be

closed. Closure of one of the ends enables the horn structure to be used as a container. The container may, if made of liquid resistant material, function as a drinking vessel. The closure for the throat may be formed as an extension of the wall. The extension may be an integral part of the wall and include additional fold lines to allow the opposed walls to be folded to seal the end of the container.

The tapered structure may also be used as an acoustic horn for a musical instrument. The acoustic horn may advantageously have a cross-sectional area which varies non-linearly (generally increasing) with the distance from the throat.

According to a second aspect of the present invention, there is provided a tapered structure comprising at least first, second and third wall portions, wherein the wall portions cooperate, in use, to form a channel, and wherein the second portion is intermediate the first and third portion, is bounded by two arcuate curves, and has a concave surface.

According to a third aspect of the present invention there is provided a sheet of material having three pairs of fold lines formed therein, wherein each pair of fold lines are arcuate and serve to define five portions, and in which the lines in each pair curve so as to define three tongue shaped portions, separated by intervening regions.

Further features and advantages of the invention will be apparent from the description below.

Embodiments of the invention will now be described, by way of example, with reference to

the accompanying drawings, in which:

Figure 1 is a perspective view of a pyramidal horn;

Figure 2 is a perspective view of a conical horn;

Figure 3 is a perspective view of a sectoral horn;

Figure 4 is a plan view of a blank for the pyramidal horn of Figure 1;

Figures 5a, 5b, 5c, and 5d are views of a horn structure in accordance with the invention in various orientations;

Figure 6 is a perspective view of another horn structure in accordance with the invention;

Figure 7 is a plan view of a blank for the horn structure of Figure 6; and

Figure 8 is a plan view of a blank for the horn structure of Figures 5a, 5b, 5c, and 5d.

Referring to Figures 5a, 5b, 5c, and 5d there is shown a horn structure which is formed by folding a sheet of material. The material may be any foldable material, such as paper, card, suitably thin sheet metal, or plastics.

The horn structure has a single wall which is wrapped around a channel or cavity, and joining back onto itself to form a hollow tube-like structure. The horn has an open base end 51, known as the mouth, having a relatively wide cross-sectional area. The cross-sectional area of the channel decreases along the length of the horn to an open truncated apex end 52, otherwise known as the throat of the horn. The horn has first and second apposed concave surfaces 54 and 55, respectively. Each surface 54 and 55 is provided with a lonitudinally extending fold line, as indicated by the chain lines 58. The first concave surface 54 extends from the throat 52 to the mouth 51 of the horn. The second concave surface 55 only extends part of the way towards the mouth 51. This results in the creation of a conical region 59 where the second concave surface and the opposed side walls 60 and 61 come together. This conical region imports structural stability into the core.

The horn can be moved between it's flat and 3-dimensional states at will. This does involve some stressing of the material of the horn, which "clicks" into its final state as the horn is constructed from its flat to its 3-dimensional form. This sudden change into the final 3-dimensional state also enhances the structural rigidity of the horn and inhibits it from inadvertently returning to its flat state. Of course, the horn may be provided without the fold lines 58 if it is not to be folded flat.

Referring also to Figure 8, there is shown a blank for the horn structure of Figures 6a to 6d. The blank includes an outline 71, and four fold lines 72, 73, 74, 75 which divide the blank into three generally elliptical areas 76, 78, 80, albeit being truncated at one end, and two generally triangular areas 77, 79. There is also a flap or tab section 81 joined by a fold line

to the generally triangular area 77. After folding the blank along the fold lines, the blank is then wrapped around onto itself such that the outer elliptical areas 76 and 80 coincide or overlap, and the flap section 81 overlaps with the area 79. With the blank folded and wrapped the horn structure of Figures 6a to 6d is formed, and may remain in that form by gluing or fastening both the overlapping elliptical areas 76 and 80, and the overlapping flap 81 and area 79 to one another in a known manner. The elliptical area 78, and the coincident elliptical areas 76 and 80 form two opposing concave panels of the horn. These panels are joined by two opposing convex panels formed by the triangular areas 77, 79. The curved nature of the fold lines, which convergence towards the base end, combined with the arc or sector like symmetrical shape of the overall blank produce a horn structure which is flared i.e. the cross-sectional area of the horn increases non-linearly with the distance from the throat. This improves the acoustic performance of the horn.

Figure 6 shows an alternative embodiment of the horn structure in accordance with the invention, in which the base end is symmetric. The blank for this horn structure is shown in Figure 7, with like references referring to like features. This blank does not include the flap or tab 81 of the Figure 8 embodiment.

Although the tapered structure in accordance with the invention is particularly useful in the field of acoustics, it may also be used beneficially in a variety of other applications. For example, by closing the truncated apex end of the structure by means of an additional, integrally folded panel, the structure may be used as a hand-held container for foods, such as sweets, or in the case of the embodiment shown in Figures 5a to 5d a scoop. Furthermore,

by use of suitable liquid resistant material or coatings, the container can be used to hold beverages. Other uses of the tapered structure include use in hat making where the curved lines provide an aesthetically pleasing appearance.

It will be evident in view of the foregoing that various modifications may be made within the scope of the present invention. For example, there may be more than two, e.g. 3 or 4, concave elliptical panels distributed around the tubular wall member. The closure of the throat may be made as a novelty shape to enhance the appearance of the horn.

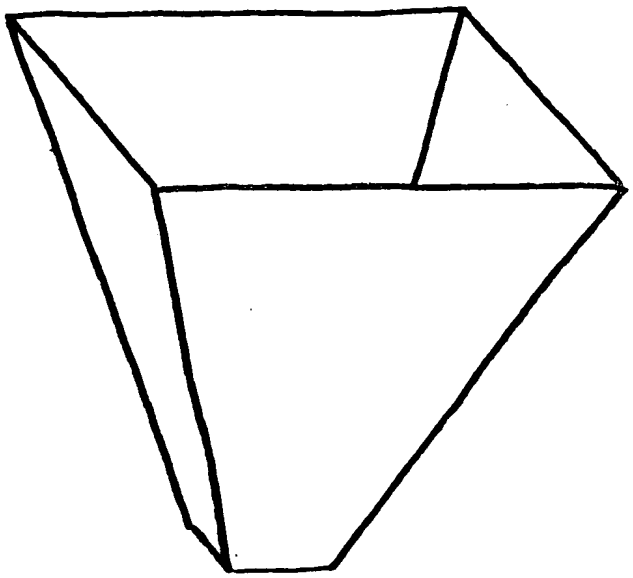

Fig. 1

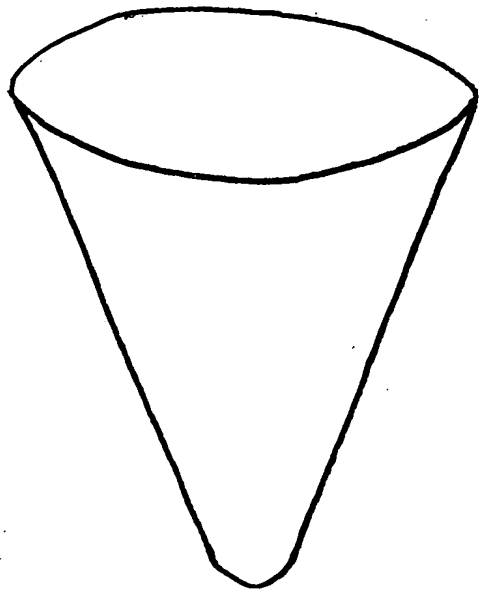

Fig. 2

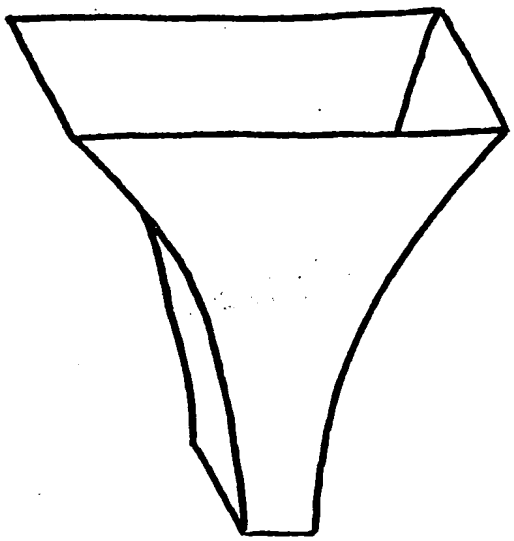

Fig.3

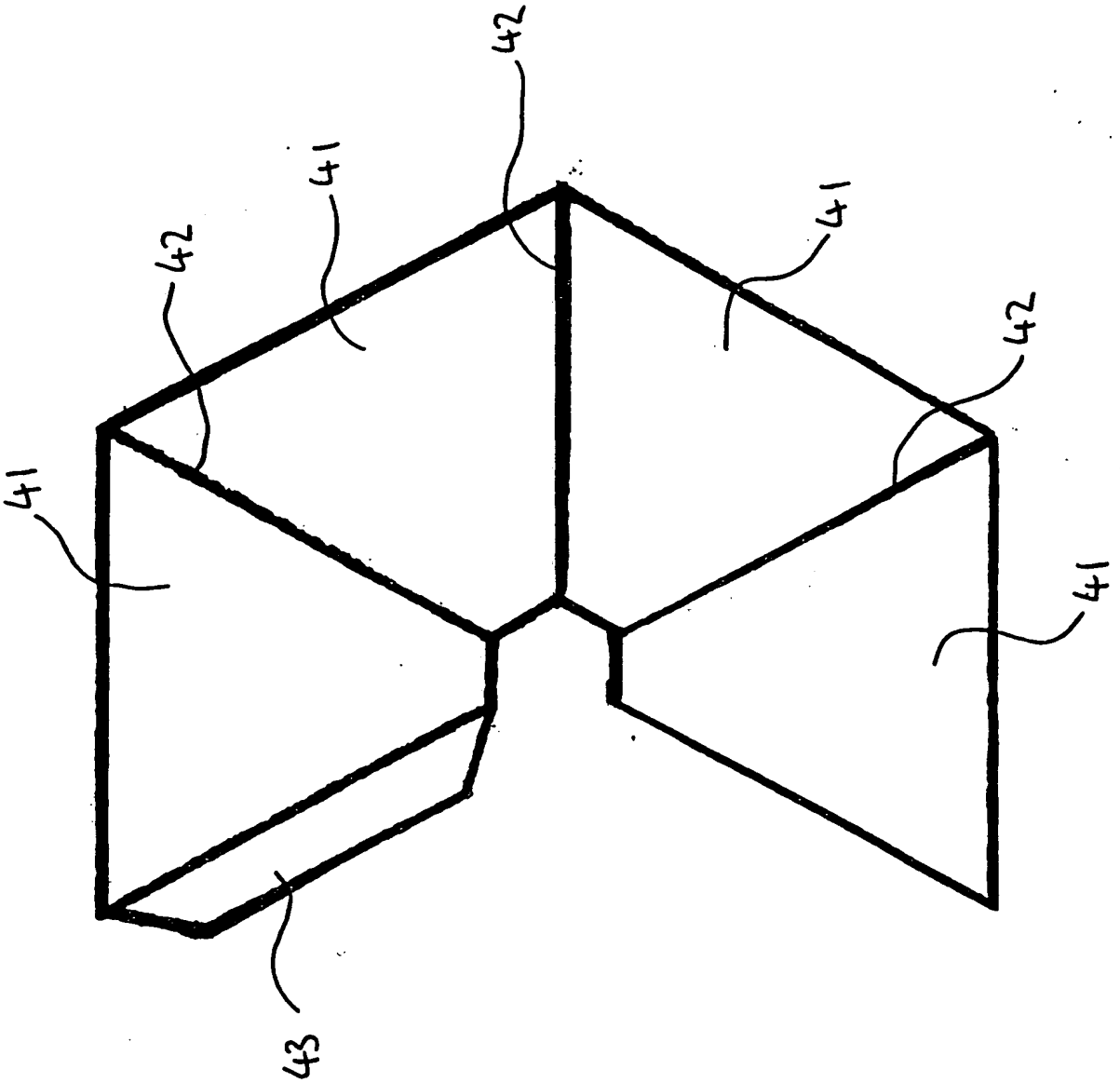

Fig. 4

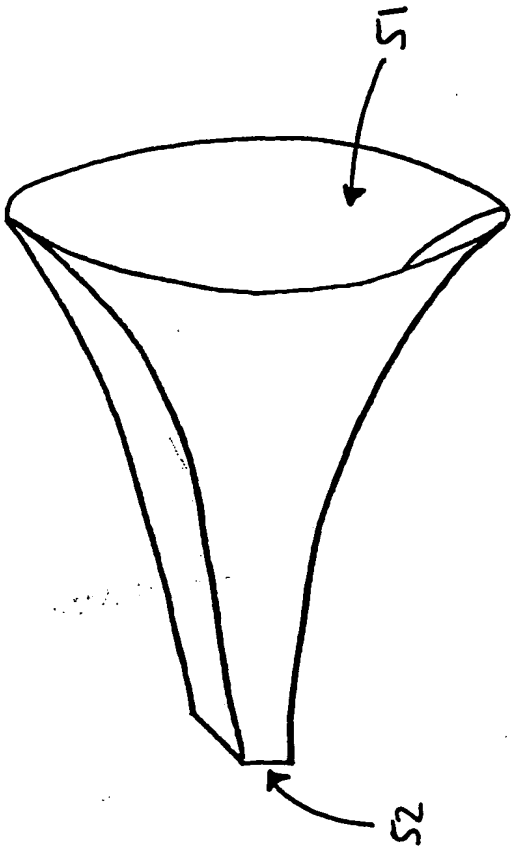

Fig. 6

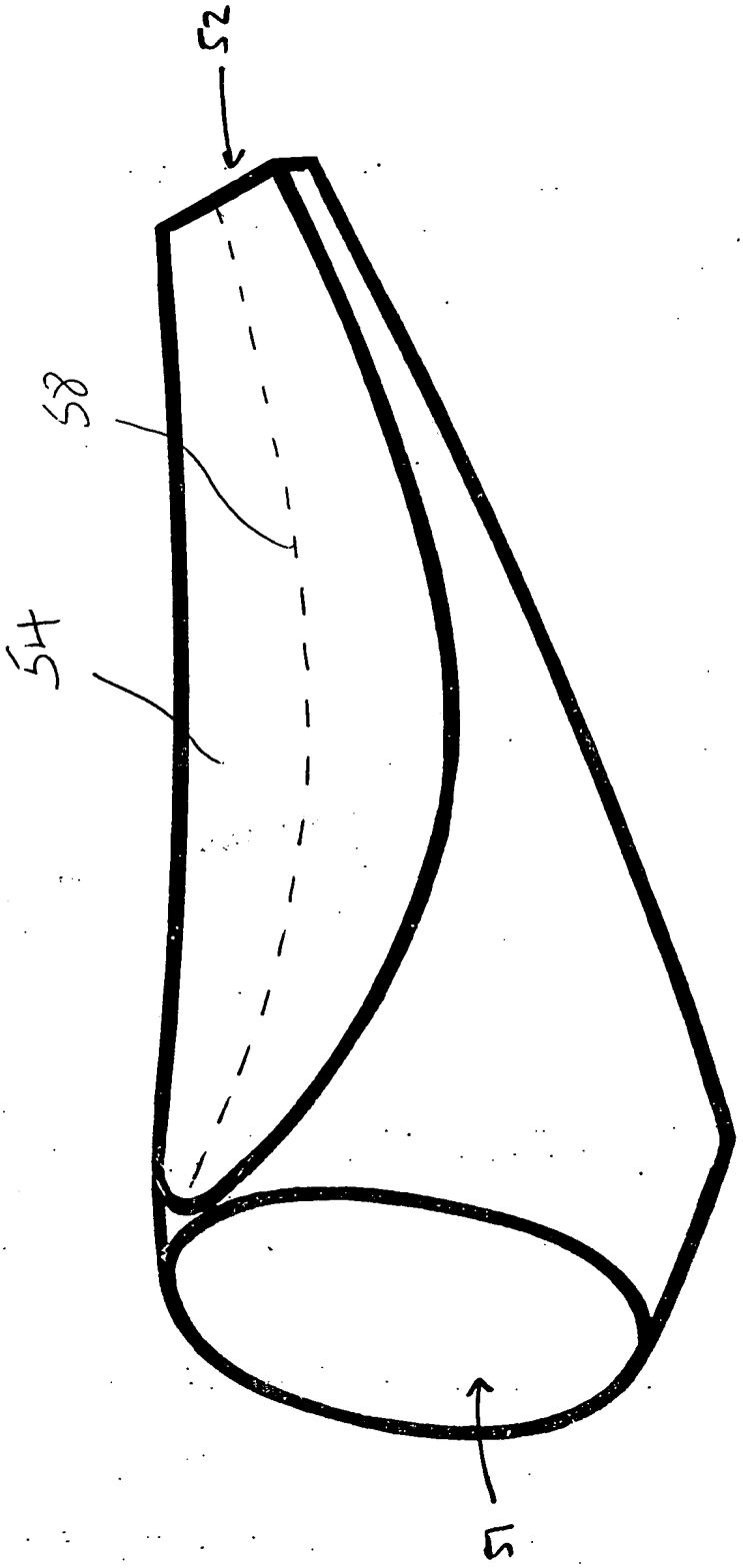

Fig. 5a

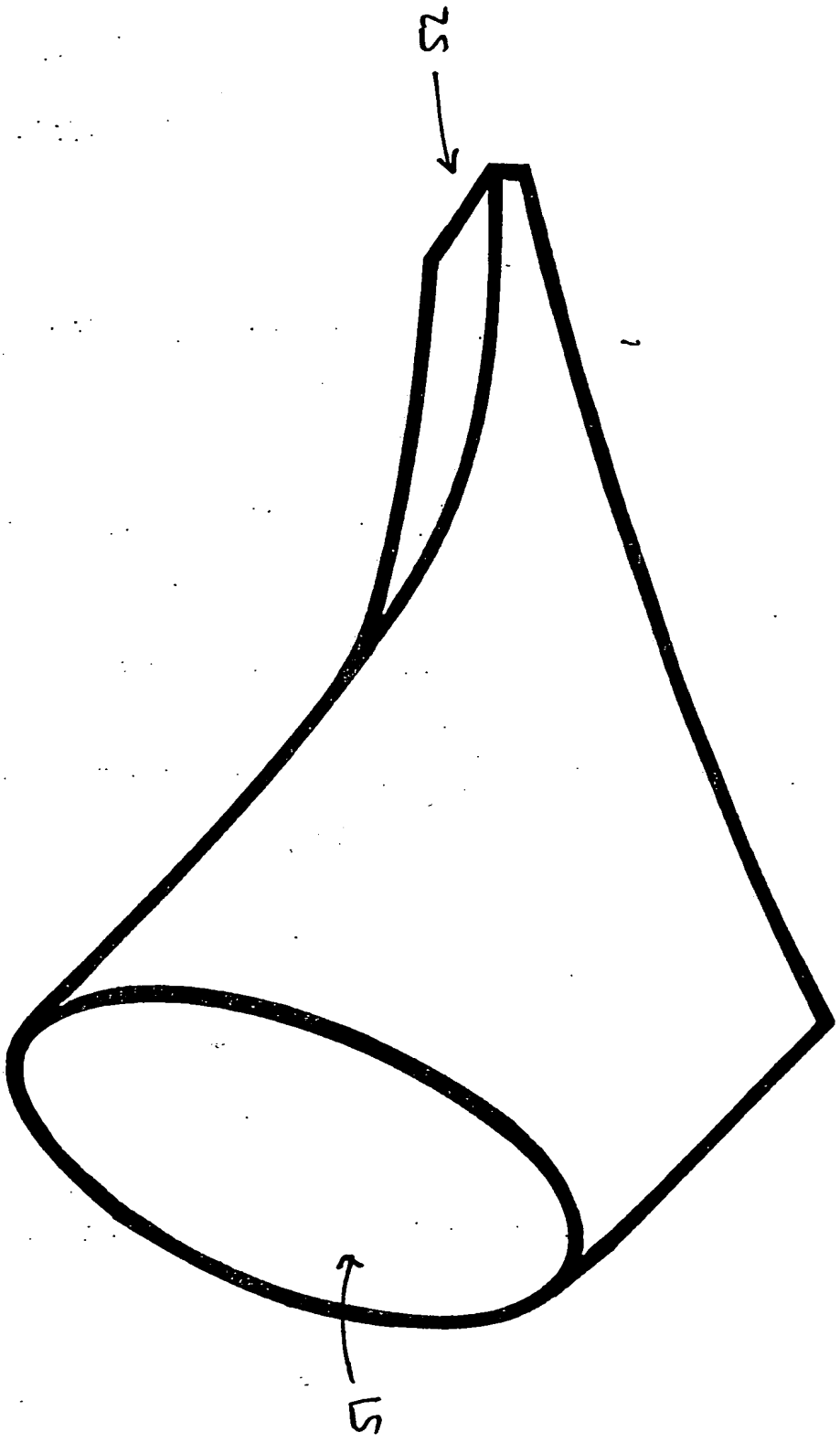

Fig.5b

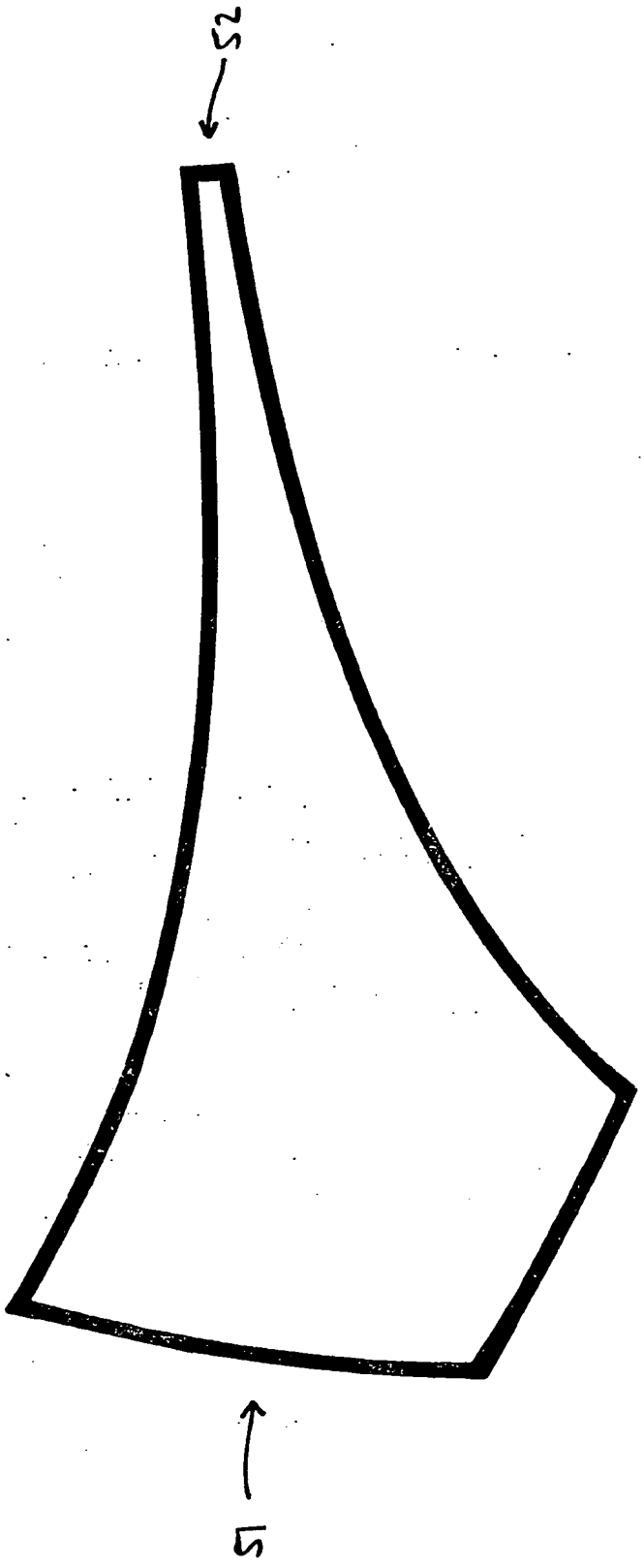

Fig.5c

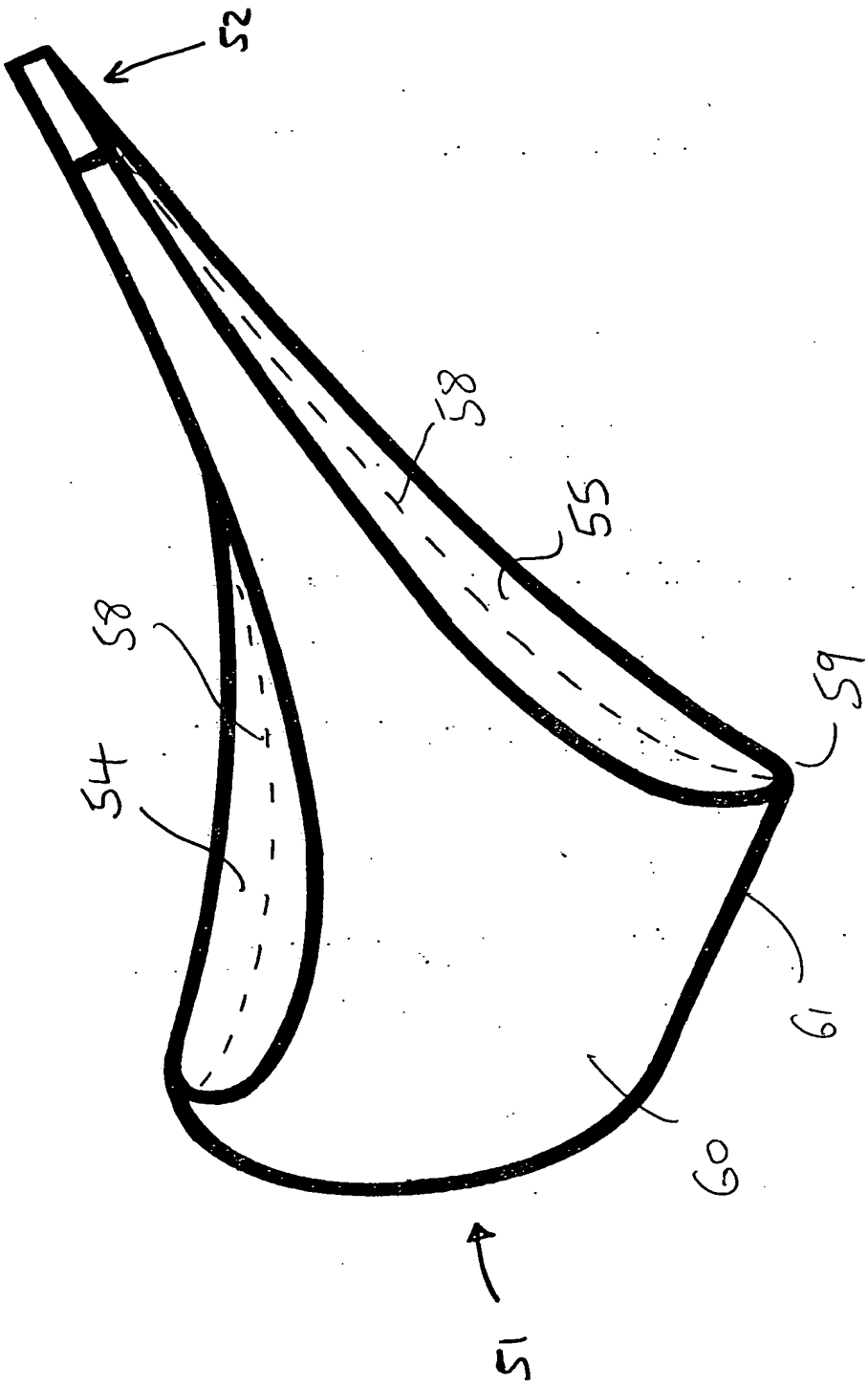

Fig. 5d

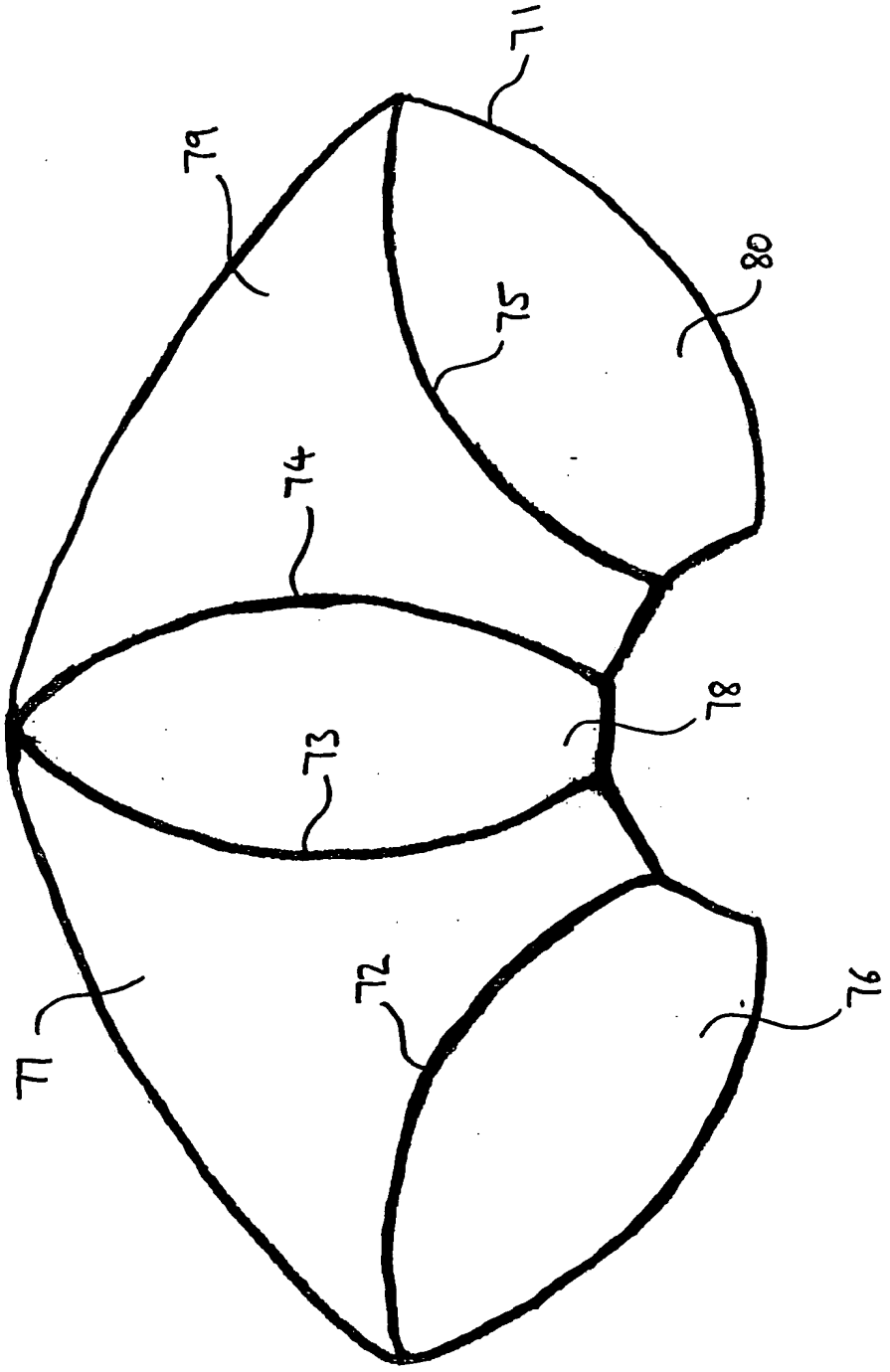

Fig. 7

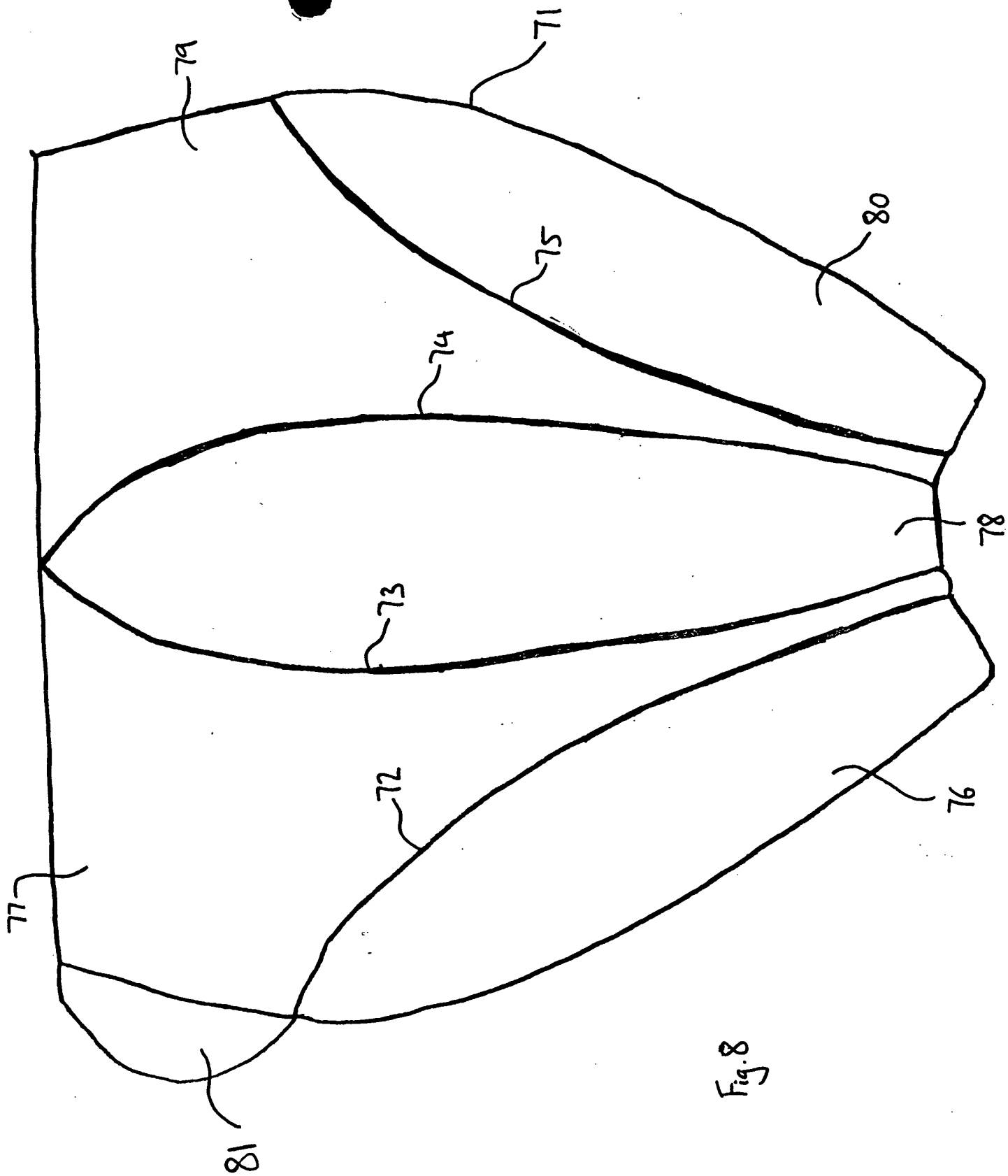

Fig. 8

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